Use Of M&S In MOT&E (OT-IIB) For The AIM-9X Sidewinder Missile Program

COTF Code 58

14 September 2004

Brief Outline

- Program Description
- Description Of M&S Tools Used During MOT&E
- MOT&E Test Event
- MOT&E M&S Application
- Why M&S Worked For The AIM-9X MOT&E
- Lessons Learned And Afterthoughts

Program Description

- AIM-9X Sidewinder short range air-to-air infrared (IR) missile is follow-on to the AIM-9M missile for Air Force and Navy/Marine Corps tactical aircraft
  - Highly maneuverable day/night, launch and leave missile with passive IR guidance to engage multiple target types
    - AIM-9X retains AIM-9M warhead, fuze, and rocket motor
    - New scanning focal plane array IR seeker, thrust-vectored tail-control actuation system, and signal processor/auto pilot

(continued)

Program Description (continued)

- Designed to work with any on-board aircraft cueing source including aircraft radar
  - When used with the Joint Helmet-Mounted Cueing System (JHMCS) allows for high off-bore sight angle (OBA) capability in target acquisition, tracking, and guidance
- Used on F-15C/D and F/A-18C/D. Current and future aircraft integration efforts include F-16, F/A-18E/F, F-15E, F/A-22, and F-35 (JSF)

Description Of M&S Tools Used During MOT&E

- Integrated Flight Simulation (IFS) Version 4.4.5 digital fly-out model
  - Simulates missile flight from acquisition through closet point of approach for both pre-programmed and guided flights (from measured field data)
  - IFS is based on a generic six degree-of-freedom (6 DOF) simulation developed by Raytheon Missile Systems (RMS) replacing the stochastic sensor/tracker model with a scene generation module, a detailed electro-optical sensor model, and the AIM-9X missile tracker algorithms
    - The 6 DOF mode of the IFS is a closed-loop simulation of the AIM-9X missile, capable of predicting kinematic fly-out performance and is used for algorithm development and kinematic assessment

(continued)

Description Of M&S Tools Used During MOT&E (continued)

- In IFS the scene generation module produces in-band IR scenes of the target, countermeasures, and backgrounds

- Joint Services Endgame Model MOD X (JSEM MOD X) Version 2.7.0.1
  - A modified version of JSEM baseline version 2.2.2 developed by NAWC-WD China Lake as government-furnished software by PMA-259 to RMS, includes the DSU-15A/B proximity fuze model and the AIM-9X warhead model
    - JSEM MOD X is also composed of target vulnerability models and a contact fuze model

(continued)

Description Of M&S Tools Used During MOT&E (continued)

- The warhead model includes fragment mass and velocity distribution algorithms
- The target vulnerability model is composed of five parts: Direct-hit kill model, Blast-fragmentation kill model, Component multiple-fragment hit kill model, Component single-fragment kill model, and a Critical component fault tree

MOT&E Test Event

- MOT&E (OT-IIB) conducted by the Air Force (AFOTEC (DET-2) supporting OTA) and the Navy (VX-9 for COMOPTEVFOR lead service OTA) May 02-Aug 03 (OT-IIA (OA) conducted Sep 99-Aug 00)
  - 22 live-fire shots were taken during MOT&E of which 15 employed CM against Air Force and Navy F-4 full scale drones as well as captive carry flights conducted
    - 15 telemetry shots and 7 warhead shots
      - Live-fire test events took place at NAWC-WD Point Mugu and China Lake, Eglin AFB, and White Sands Missile Range

MOT&E M&S Application

- IFS/JSEM MOD X used to supplement the evaluation of operational effectiveness of the AIM-9X Weapon System during MOT&E due to:
  - Limited number of missiles available for OT
  - Related range infrastructure and support cost limitations
  - Limited number of full scale drones available
    - Navy QF-4
    - Air Force QF-4
    - PTA not available
      - Cost
- Specifically the M&S used for:
  - Preflight planning
    - Testability
    - Kinematic envelope
    - Countermeasures and backgrounds

(continued)

MOT&E M&S Application (continued)

- Augmented live-fire testing to evaluate Lethality (COI 2): Will the AIM-9X increase the lethality of the host platform in day/night within the visual range air-to-air arena?
  - MOE 2-1. Aggregate probability of kill (P_k) broken out into two aggregate values per ORD: P_k with countermeasures and P_k without countermeasures
    - F-4 full scale drone
    - PTA
      - 308 total M&S runs: 192 with IRCM and 116 without IRCM

Why M&S Worked For This MOT&E

- Commitment from model developers (Raytheon and NAWC-WD China Lake) and proponent (PMA-259)
  - Adequate resources provided as far as technical support, funding, and M&S hardware
    - V&V documentation contract deliverables (Just as important as the missile)
    - EM&D M&S funding $5M (97-01), accreditation support funding $2M (00-03), other support costs $1M/yr (01-present): total M&S costs approximately $10M (97-03)
      - Not cheap but still less than $1-2M/shot as long as the M&S tools are useful

(continued)

Why M&S Worked For This MOT&E (continued)

- PMA-259 performed three DT accreditations
  - Specification compliance in support of Certificate of Design
  - Low Rate Initial Production Defense Acquisition Board
  - Live Fire Test and Evaluation
- Commitment from both OTAs including supporting activities and squadrons
  - Fully engaged in the VV&A process from the beginning
    - Attended all V&V reviews as panel members of Acceptability Acceptance Review Panels (AARP) and Accreditation Review Panels (ARP)
      - 15 formal AARP meetings from Oct 99-Sep 03 and 3 DT ARP meetings
      - Focused on how simulations would be used for MOT&E
      - Identified issues early and throughout process
      - Agreed upon validation acceptance criteria and methods
      - Joint Accreditation Support Activity (JASA) support as Accreditation Agent for both OTAs
  - AFOTEC obtained hardware and M&S expertise to run IFS and JSEM MOD X

Lessons Learned And Afterthoughts

- Provide MOT&E M&S planning documentation earlier in the process to developers/proponent
  - Hurry and finish up
- “Real” acceptance criteria-be careful
  - Fly-out comparisons
    - Actual versus Memorex
  - Statistical Tests
    - Fisher Combined Probability Test
    - Kolmogorov-Smirnoff Test
    - Chi-Squared Test
- Is long and drawn out…need commitment from alcon
  - Remember Oct 99-Sep 03
- Trusted agent support from model developers (Raytheon and NAWC-WD China Lake
- Applying lessons learned and methodology to other Air Warfare Air Weapons programs
  - FOT&E of AIM-9X (DT-III/OT-III)
  - AMRAAM P3I Phase 3 FOT&E 4A (AIM-120C-7)
  - Joint Common Missile (JCM)
  - AMRAAM Phase 4 (AIM-120D)